25 CM. SPHERES

6 CM. SPACING

NEGATIVE POLARITY

MEASUREMENT DIVIDER

HIGH SIDE = 7-125 Ω CARDS

LOW SIDE = 4.07 Ω SHUNT

$$\frac{3 \times 10^{2}}{.74 \times 10^{-7}} = 4 \times 10^{9}$$

($\underline{161}$ is negative spark over of a 25 cm sphere gap at 6 cm spacing.)

Questions

1.) May I consider the Cigre Study Committee Curve (Fig. 2) as having a zero response time. $\left(\frac{U_{0c} - U_0}{S} = T_r = 0\right)$

2.) If $U_0 = U_{0c}$ in Cigre Study Committee Curve, then I can consider that:

$$\frac{U_{0c} - 161}{S} = \text{ordinate axis scale}$$

3) I find some discrepancies in the equation:

$$\frac{(U_{0c} - a_2)^2}{S} = \text{constant}$$

at $S = .15$ $\quad \frac{(U_{0c} - 161)^2}{.15} = \underline{4,780}$

at $S = 1.0$ $\quad \frac{(U_{0c} - 161)^2}{1.0} = \underline{4,489}$

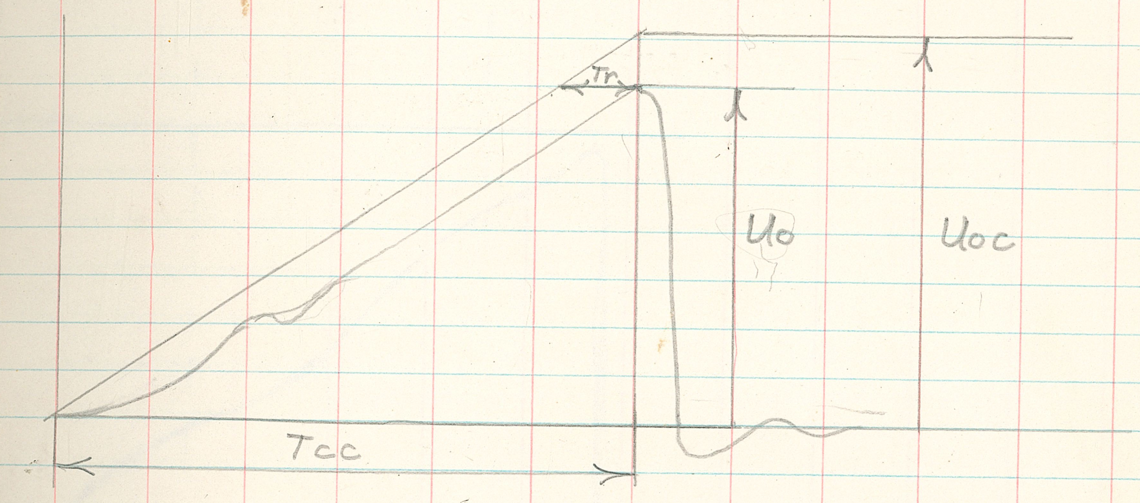
at $S = 10.$ $\quad \frac{(U_{0c} - 161)^2}{10} = \underline{4,000}$

4) How do I interprete the results of a breakdown in air across an insulator, using a measuring divider with a response time = $\underline{19.7\,ns}$

? If: $U_0 = 302\,KV$ breakdown in air @ $74\,ns$ $\left(\frac{KV}{ns} = 4\right)$
and: $U_{0c} - U_0 = S\,T_r$
then: $U_{0c} = S\,T_r + U_0$

$$\frac{U_o - 161}{S} = \text{ordinate axis scale}$$

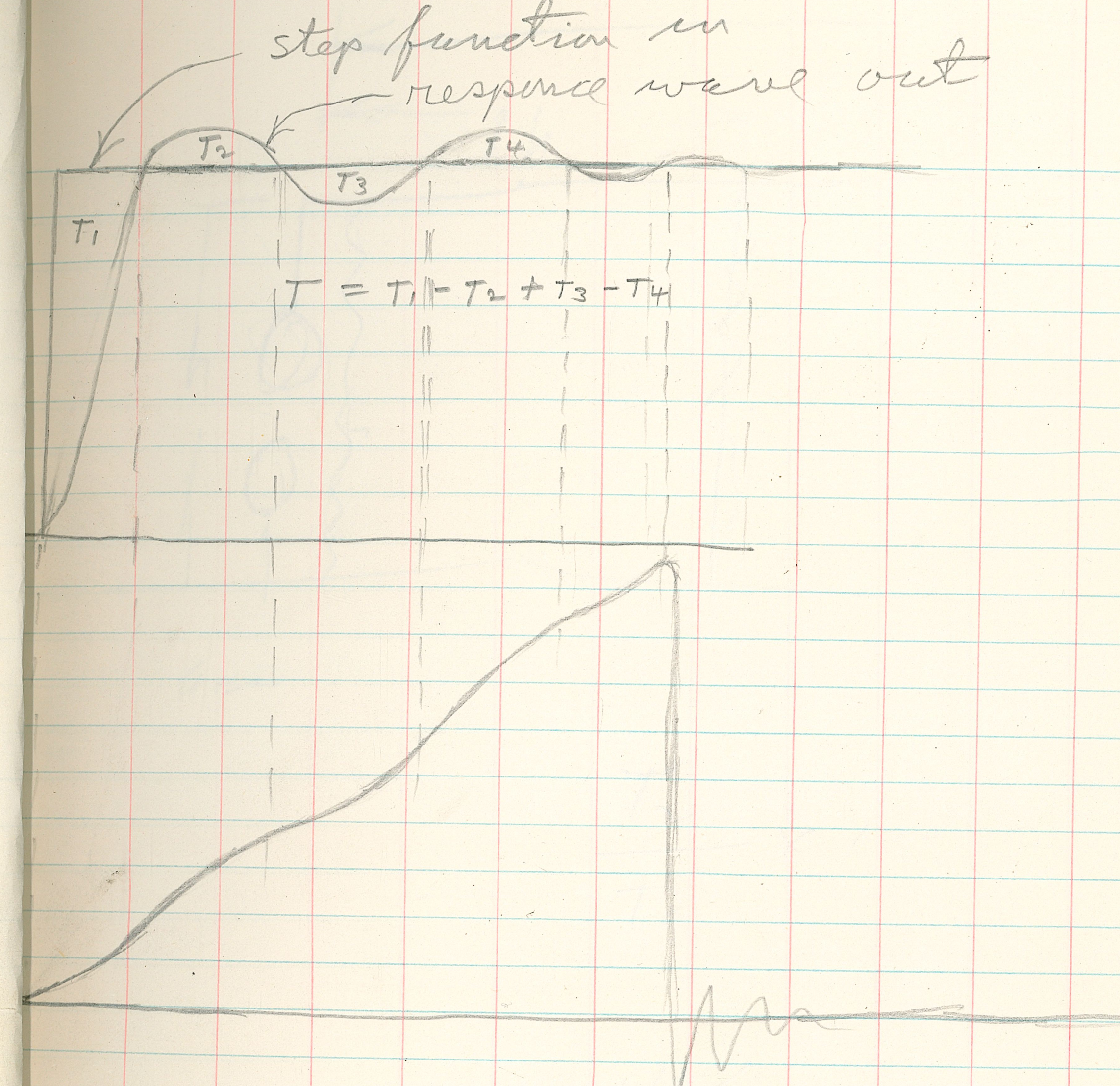
$$\frac{(U_{oc} - 161)^2}{S} = \text{constant}$$



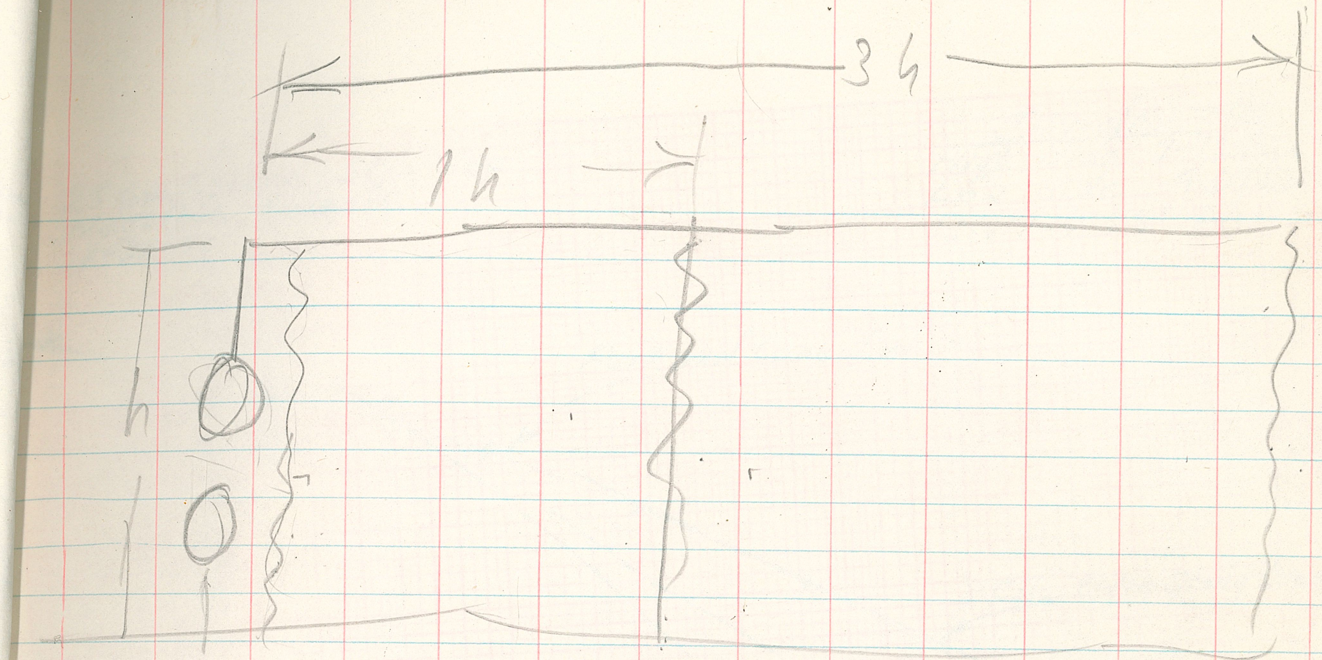
the measurement error is estimated at:

$$U_{oc} - U_o = S T_r$$

$$\frac{U_{oc} - U_o}{S} = T_r$$


step function in
responce wave out
T_1
T_2
T_3
T_4
$T = T_1 - T_2 + T_3 - T_4$

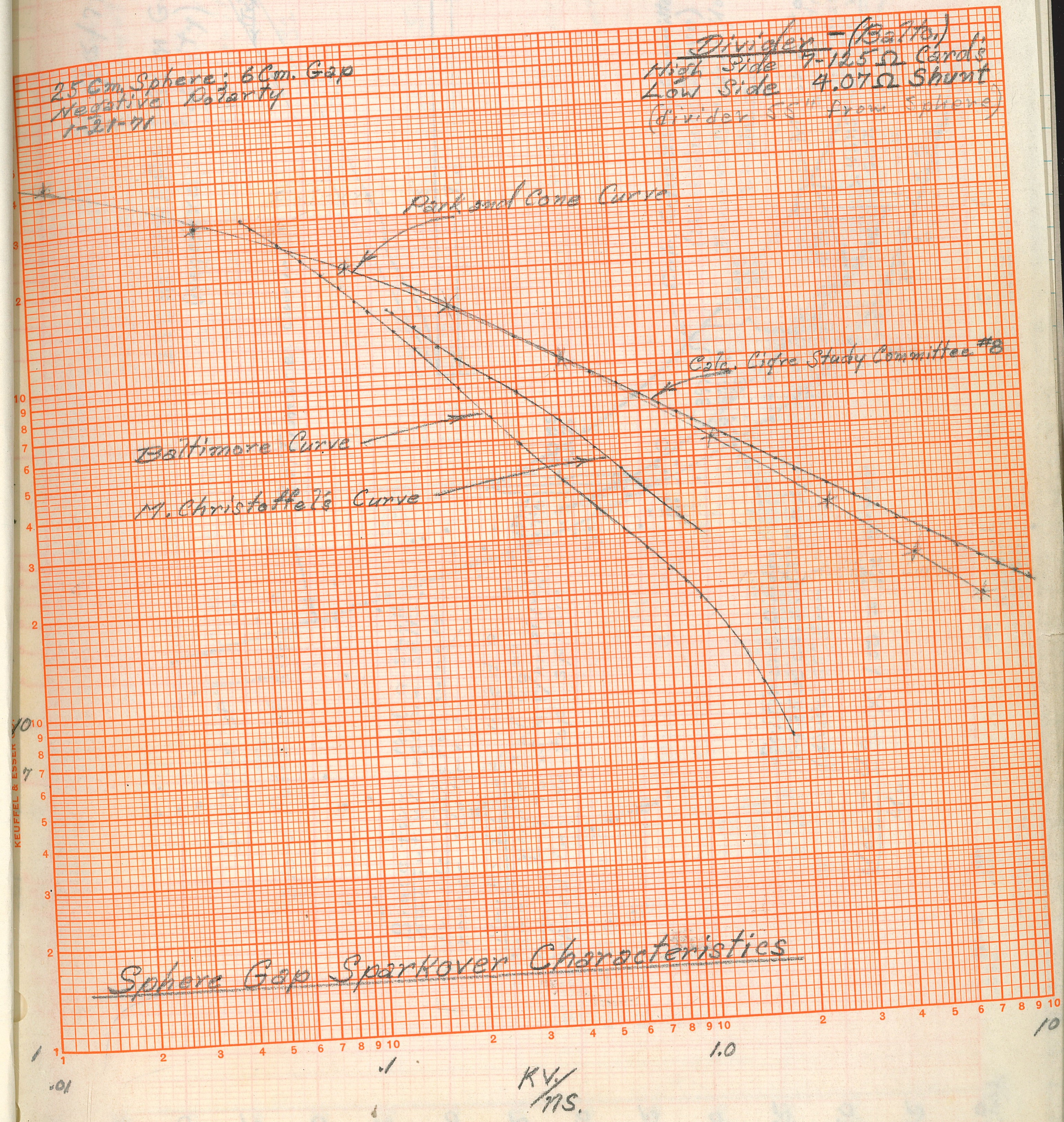
.060



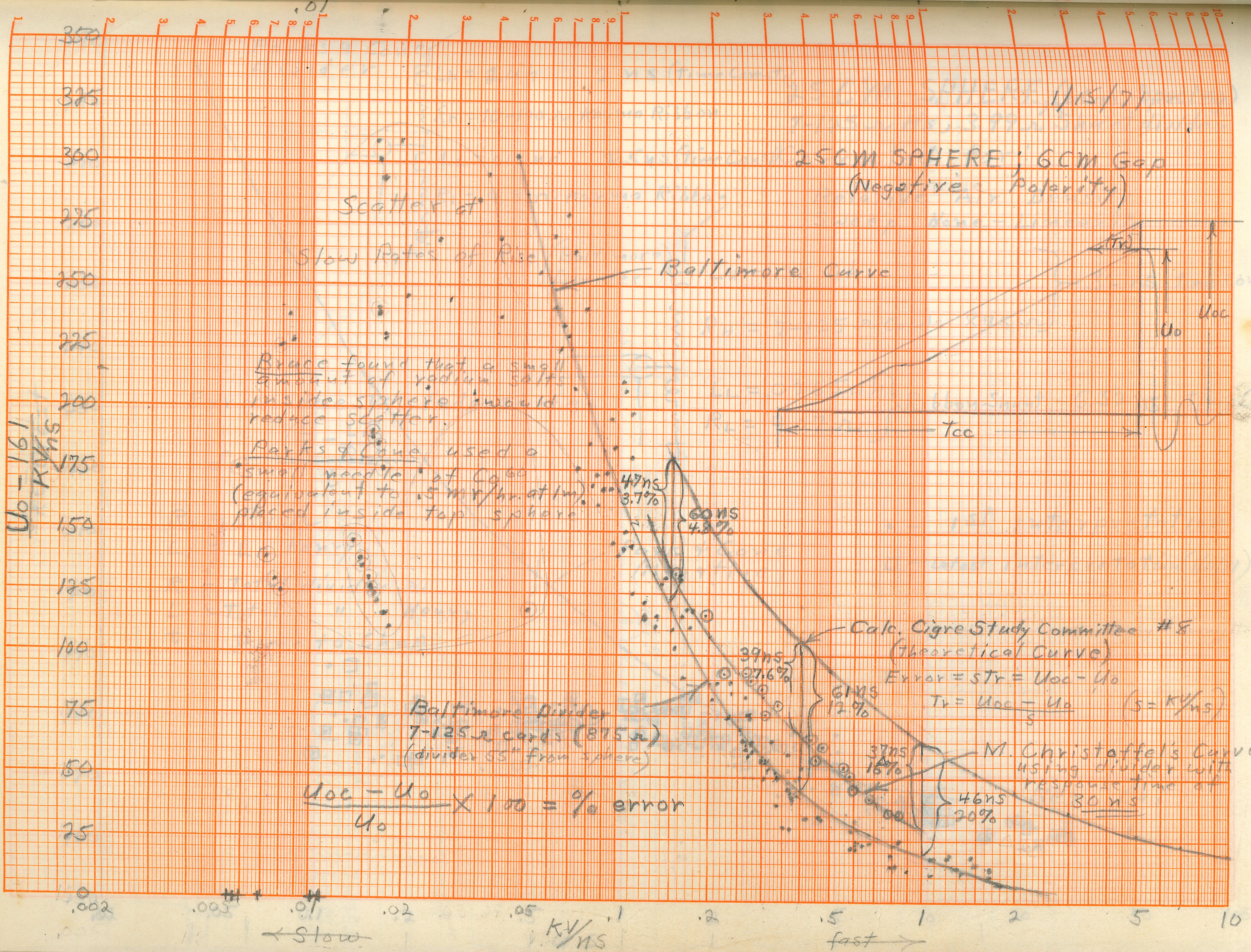
One

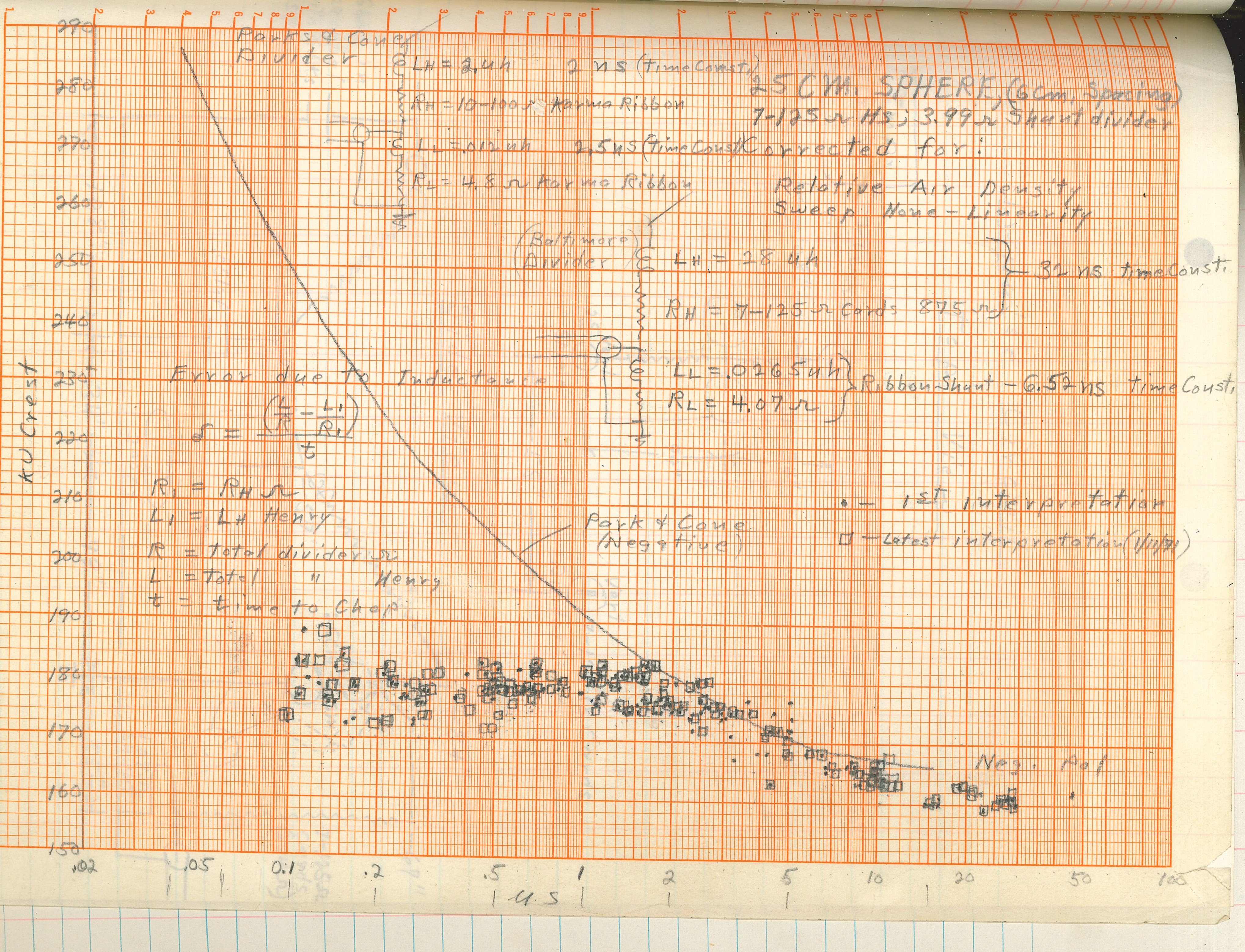
$$\frac{T_2}{T_1} \times 100 = \% \text{ error}$$

1 ft/ns speed of light



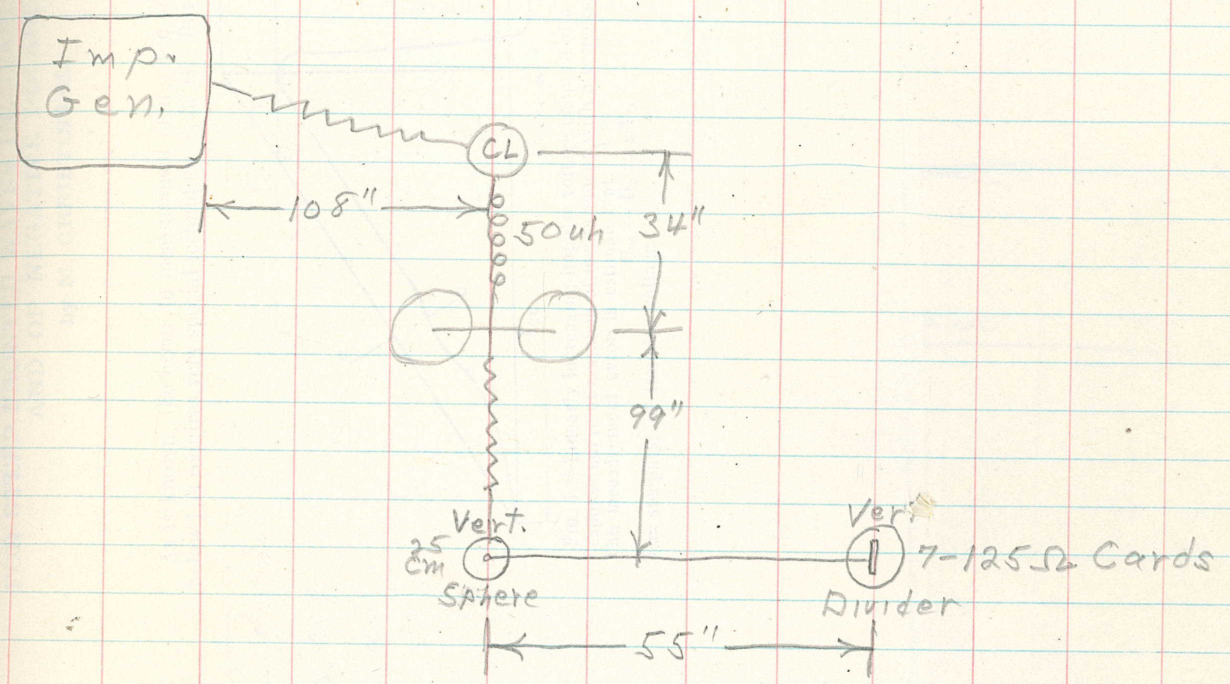
25 Cm. Sphere; 6 Cm. Gap
Negative Polarity
1-21-71
Divider – (Balto.)
High Side 7-125 Ω Cards
Low Side 4.07 Ω Shunt
(divider 55" from Sphere)
Park and Cone Curve
Calc. Cigre Study Committee #8
Baltimore Curve
M. Christoffel's Curve
Sphere Gap Sparkover Characteristics
.01
.1
1.0
10
KV/
ns.


1/15/71
25CM SPHERE ; 6CM Gap
(Negative Polarity)
Baltimore Curve
Scatter at Slow Rates of Rise
Bruce found that a small amount of radium salts inside sphere would reduce scatter.
Parks & Cone used a small needle of Co^{60} (equivalent to .5 mr/hr. at 1m) placed inside top sphere
Tcc
Tr
Uo
Uoc
47ns 3.7%
60ns 4.3%
39ns 7.6%
61ns 12%
37ns 16%
46ns 20%
Calc. Cigre Study Committee #8 (Theoretical Curve)
Error = STr = Uoc - Uo
$Tr = \frac{Uoc - Uo}{S}$ ($S = KV/ns$)
M. Christoffel's Curve using divider with response time of 30 ns
Baltimore Divider 7-125 Ω cards (875 Ω) (divider 55" from sphere)
$\frac{Uoc - Uo}{Uo} \times 100 = \%$ error
Uo - 161 KV/ns
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
.002
.005
.01
.02
.05
.1
.2
.5
1
2
5
10
KV/ns
← Slow
fast →

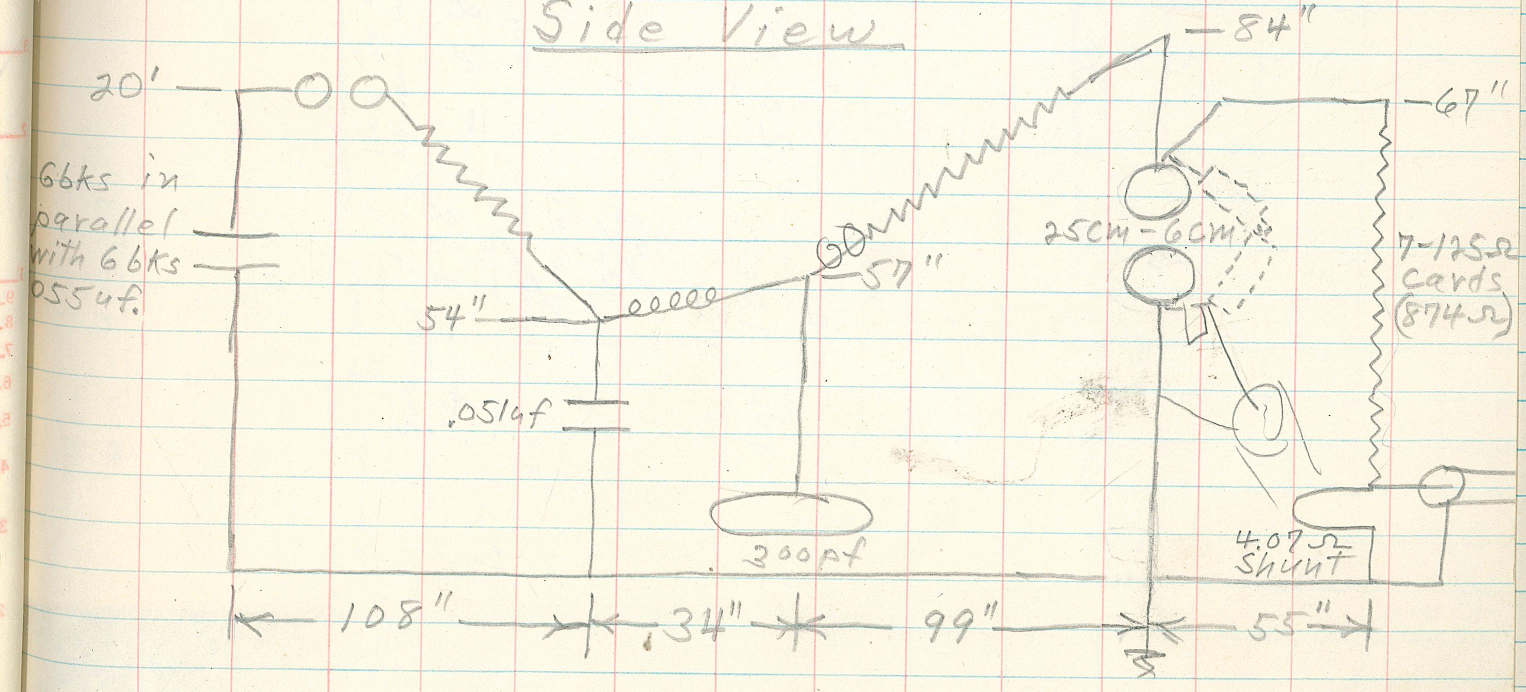

25 CM. SPHERE, (6cm. Spacing)
7-125 Ω Hs; 3.99 Ω Shunt divider
Corrected for:
Relative Air Density
Sweep Non-Linearity
Parks & Cone Divider
LH = 2.4 uh
2 ns (time Const.)
RH = 10-100 Ω Karma Ribbon
LL = .012 uh
2.5 ns (time Const.)
RL = 4.8 Ω Karma Ribbon
(Baltimore) Divider
LH = 28 uh
RH = 7-125 Ω Cards 875 Ω
32 ns time Const.
LL = .02654 uh
RL = 4.07 Ω
Ribbon Shunt - 6.52 ns time Const.
Error due to Inductance
$\delta = \frac{\left(\frac{L}{R} - \frac{L_1}{R_1}\right)}{t}$
$R_1 = R_H$ Ω
$L_1 = L_H$ Henry
R = total divider Ω
L = Total " Henry
t = time to Chop
Park & Cone (Negative)
• - 1st interpretation
□ - Latest interpretation (1/11/71)
Neg. Pol
KV Crest
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
.02
.05
0.1
.2
.5
1
2
5
10
20
50
100
μs

Impulse Circuit

Top View



Side View



of linearly increasing chopped front impulse voltages, the error of measurement is directly proportional to the response time T_r (see *Fig.* 1 and Ref. 3). For a fairly long time and in addition to the usual low voltage method, it has been proposed to determine the response time T_r of a measurement system, by a high voltage method based on the comparison of the measured spark-over characteristic with the actual spark-over characteristic.

$$\frac{KV}{\frac{KV}{us}} = \cancel{KV} \times \frac{us}{\cancel{KV}} = us \qquad \frac{KV}{\frac{KV}{us}}$$

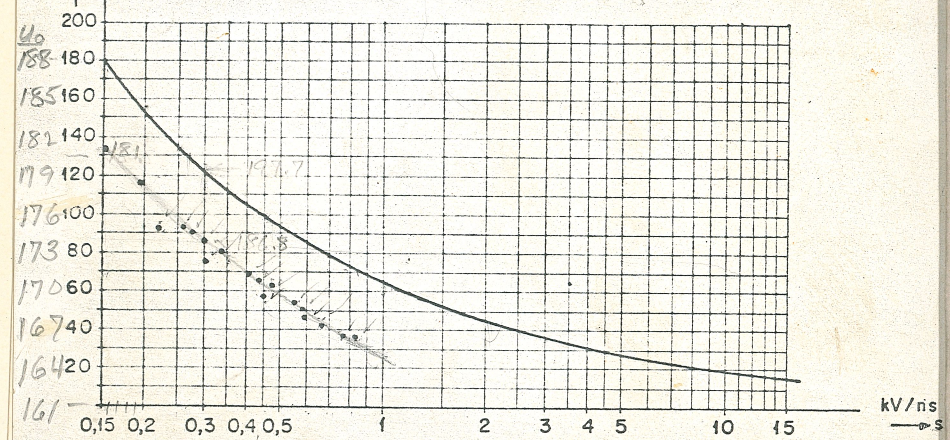


FIG. 2.—Spark-over characteristic of a sphere-gap (s = 60 mm, D = 250 mm) for linearly increasing negative impulse voltages.
The points represent the results of tests with measurement systems having a response time of T_r = 30 ns.
U_0 = spark-over voltage 760/20 (kV);
s = steepness (kV ns^{-1}).

In 1964 a working party of Cigre Study Committee No. 8 requested a certain number of laboratories to record the spark-over characteristics of 2 sphere gaps, with the object of determining on this basis, the actual characteristic with the greatest possible degree of accuracy. This present report deals only with the S = 60 mm, D = 250 mm sphere gap. During the discussion held in Vienna, there were in all 15 series of tests [6]. For the interpretation of these test results, a physical hypothesis was used [5, 6] from which were obtained:

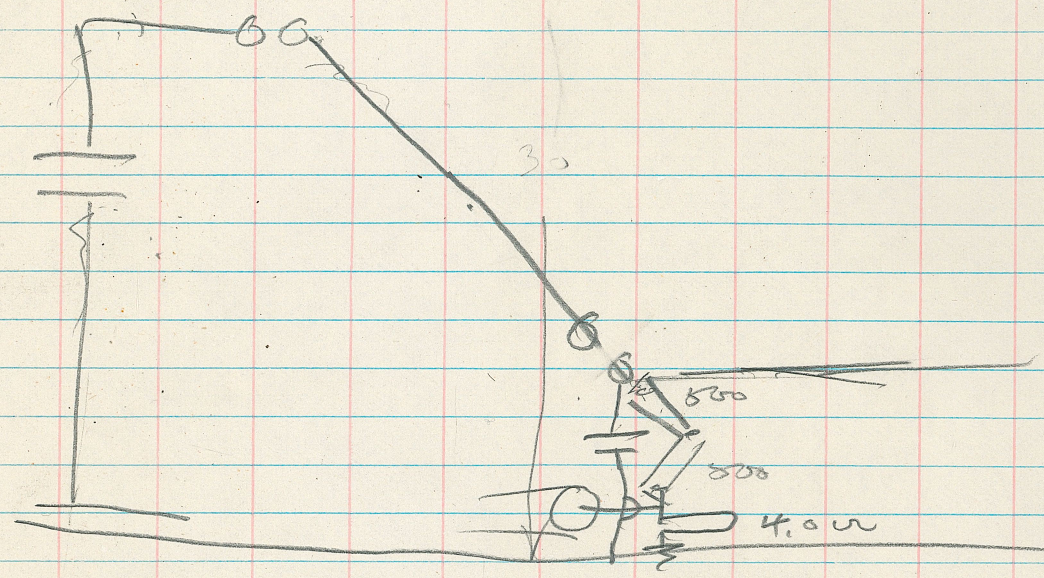
$$\frac{(U_{oc} - a_2)^2}{s} = \text{constant.} \qquad (1)$$

If the hypothesis is true, for a measurement system having a response time $T_r = c_2$, the following equation is obtained:

$$\frac{U_0}{s} = a_2 \cdot \frac{1}{s} + b_2 \cdot \sqrt{\frac{1}{s}} + c_2. \qquad (2)$$

$$\frac{U_0}{S} = 161 \times \frac{1}{S} + 62 \times \sqrt{\frac{1}{S}} + c_2$$

3/



~~200~~ 376

$$\frac{200}{376} \times 150\ kV \times 6$$

$$\frac{135}{50}$$

1

900

400×10^3

$$\frac{4 \times 10^5}{10^3} =$$